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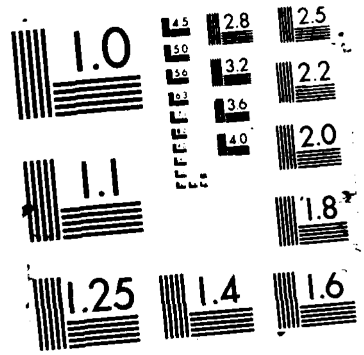
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This equipment grant allowed the purchase of SUN computer work stations and equipment for networking. Prof. Isenberg has been using his work station to perform symbolic symmetry calculations. Prof. Gibson has been using his workstation to run codes involves in his research on N-body quantum-mechanical scattering theory, and the development of an N-body computer to make scattering calculations.

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AFOSR-TR- 87-1173

Final Scientific Report
DoD-URIP Grant AFOSR-85-0092

Professor S. Steinberg, Principal Investigator
Professor T. Kyner
Professor A. Gibson
Department of Mathematics and Statistics
University of New Mexico
Albuquerque, New Mexico 87131

January 15, 1987

~~The~~ grant consisted of two parts: the installation of a Local Area Network and the installation of a network of four graphics workstations. The Local Area Network (LAN) was operational in June of 1986. The department has about 25 terminals connected to the network. Most of the terminals are located in the offices of the faculty and graduate students, with a few in a joint-use equipment room. The response is that this has greatly improved the departmental computing environment. In addition, 7 faculty members have been given microcomputers by the university and these have been connected to the LAN. This configuration seems to provide an excellent computing environment. Some of the faculty have found that current microcomputers are too small and have too little software, so the university will hopefully replace some of these with more powerful micros, which will also be connected to the LAN. This network has and will continue to have a substantial impact on the research and teaching in the department. However, ~~we see~~ no easy way to verify this except through the informal reports of the people using the system. Such informal reports have all been enthusiastic.

The network of workstations was operational in August of 1985. The network of workstation consists of four Sun-2/160 minicomputers; each has a tape and disk drive. ~~They~~ are connected via an ethernet, which is connected to the university CDCN. The Sun workstations have been upgraded to Sun-3 class workstations; three of the workstations have 4-megabyte memories while one has an 8-megabyte memory; one has a floating point accelerator. One of the disk drives is a 400-megabyte Eagle. An HP-plotter has been recently connected to the system and a plotting software package has been installed.

What follows are short reports by each of the faculty members who are using workstations. The faculty members are Professors Steinberg, Gibson, and Kyner.

1 Stanly Steinberg

Professor Steinberg has been using his workstation for both general computation and research work. The general computing includes text processing such as the preparation of research papers and course materials. The research projects include symbolic symmetry calculations and symbolic and numeric grid-generation calculations. One of the workstations was for Prof. Buys, who is on a three-year leave at the University of Arizona. During this time, two of Professor Steinberg's students are using her workstation.

One of the main uses for the workstations is to do symbolic calculations. In the fall of 1985, the symbol manipulators, MACSYMA and SMP, were installed on the system. The manipulator, Maple, has recently been installed; Reduce is still on order. The workstations have now been used to do many symbolic calculations; the system provides an excellent environment for doing symbolic calculations. The additional speed provided by the Sun-3 upgrades has made the system substantially more useful.

Professor Steinberg has developed a set of MACSYMA programs for calculating symmetries of ordinary and partial differential equations. He and Professor Buys have used these programs to calculate the symmetries and integrals of rigid bodies including the Euler, Lagrange, and Kovalewski tops. During the fall 1985 break between classes, several of these computations were run on a university VAX computer. The jobs take between 20 and 40 cpu hours, with a total cost of about $8,000.00. It would be impossible to run such jobs during the semester. About 5 times as many of these calculations have now been run on the workstation. This type of research would be impossible, from both time and money considerations, without the workstation.

Professor Steinberg has also been working on a project that uses variational methods to generate adaptive numerical grids. An important step in the methods uses the symbol manipulator, MACSYMA, to write FORTRAN subroutines. In the early stages of this project, the subroutines were very expensive to write; some required about 10 cpu hours on the workstation. As our techniques improve, the subroutines are shortened and, consequently, less computing power is needed to write them. However, the initial (poorly written) subroutines are critical because they dictate what improvements are needed. Again, such research would be difficult or impossible to carry out on the university computers, so the workstations have been critical in this project. In addition, all of the handwritten FORTRAN code necessary for the grid generation project has been developed on the workstation. Soon, a high-resolution color graphics capability will be incorporated into the grid generation codes. These codes show substantial promise as general purpose grid generation codes that could be incorporated into many modeling programs.

Professor Steinberg is currently exercising the two-dimensional surface grid generation and the three-dimensional grid generation codes. It has become clear that the Sun-2 systems are not fast enough to adequately exercise these codes. The Sun-3 systems are adequate in this respect.

Two of Professor Steinberg's Ph.D. students are using the workstations in their thesis work. Mr. Michael Wester is working on a project to implement a powerful symbolic matrix eigen package for MACSYMA. He is programming much of this work in LISP, which will give the programs enhanced speed and versatility. Mr. Jose Castillo is working on generating adaptive grids by directly minimizing variational integrals. He uses one of the workstations for writing and running his FORTRAN programs.

Ms. Megan Florence has written a master's practicum project under the direction of Professor Steinberg. She created a library of MACSYMA programs that can be used to solve and analyze an arbitrary higher- order system of ordinary differential equations. She has completed some programs that can take a system of higher-order ODEs, reduce them to a first order system, and then write the FORTRAN subroutines that are required to solve the system numerically. She is continuing her work and is currently implementing a solver for higher order systems of linear constant coefficient equations. This solver will eventually use the eigen package being written by Mr. Wester. An undergraduate student, David Scott-Collett, is just starting a project to analyze whether or not various symbol manipulators can do all of high school mathematics.

In August of 1986, Mr. P. Ananthakrishnan, a student of Professor Ronald Yeung of the Naval Architecture School at the University of California at Berkeley, visited Professors Steinberg and Roache at UNM. His visit was sponsored by an ONR contract. He came to learn about the Sun computer system, MACSYMA, and numerical grid generation. In fact, Mr. P. Ananthakrishnan was already somewhat familiar with this material. Consequently, he was well prepared to understand what was being done at UNM. While here he converted one of his graphics codes to the Sun system and we are now using that code to display our grids. His visit was a **huge** success.

The workstations were used in some way for the following papers and presentations.

Publications

1. S. Steinberg, J. E. Castillo, and P. Roache, Mathematical aspects of variational grid generation II, to appear in the Journal of Computational and Applied Mathematics.
2. S. Steinberg and P. Roache, AIAA 24th Aerospace Sciences Meeting, A Toolkit of Symbolic Manipulation Programs for Variational Grid Generation. Also to appear in the proceedings of the Fourth Army Conference on Applied Mathematics and Computation.
3. J. E. Castillo, S. Steinberg, and P. Roache, On the folding of numerically generated grids, to be published in Applied Mathematics and Computation.
4. M. Florence, MACSYMA-izing FORTRAN Code, *MACSYMA Newsletter*, **III-3** (1986), 8-12.
5. J. E. Castillo, Mathematical aspects of variational grid generation I, contributed paper presented at the International Conference, Numerical Grid Generation in Computational Fluid Dynamics, Landshut, W. Germany, July 1986, published on conference proceedings.
6. J. E. Castillo, S. Steinberg, and P. Roache, On the folding of numerically generated grids: Use of reference grids, submitted to *Communications in Applied Numerical Methods*.

Presentations

1. S. Steinberg and P. Roache, AIAA 24th Aerospace Sciences Meeting, A Toolkit of Symbolic Manipulation Programs for Variational Grid Generation, January 1986.
2. J. E. Castillo, Folding of Numerical Grids: Use of Reference Grids, conference presented at the ACM Rio Grande Chapter SIGNUM Meeting, Albuquerque, New Mexico, March 1986.
3. S. Steinberg and P. Roache, Fourth Army Conference on Applied Mathematics and Computing, A Toolkit of Symbolic Manipulation Programs for Variational Grid Generation, May 1986.

4. S. Steinberg, J. Castillo, and P. Roache, 10th U.S. National Congress of Applied Mechanics, Austin, Texas, On the folding of numerically generated grids: Use of reference grids, June 1986.

5. S. Steinberg and P. Roache, NSF Workshop of Computational Engineering, University of California at San Diego, Policy recommendations for NSF program in computational engineering, June 1986.

6. J. Castillo, International Congress on Computational and Applied Mathematics, University of Leuven, Belgium, Mathematical aspects of variational grid generation I, July 1986.

7. S. Steinberg, J. Castillo, and P. Roache, International Congress on Computational and Applied Mathematics, University of Leuven, Belgium, Mathematical aspects of variational grid generation II, July 1986.

8. S. Steinberg and P. Roache, Numerical Grid Generation in Computational Fluid Dynamics Conference, Landshut, W. Germany, Grid Generation: A Variational and Symbolic-Computation Approach, July 1986.

9. S. Steinberg, Computational Modelling for the Sixth International Conference on Mathematical Modelling, St. Louis, Missouri, Invited paper, August 1986.

10. J. E. Castillo, A Large-Scale Non-Linear Optimization Problem Arising From Grid Generation, Conference presented at the ACM Rio Grande Chapter SIGNUM Meeting, Albuquerque, New Mexico, December 1986.

11. J. E. Castillo, S. Steinberg, and P. Roache, On Folding of Numerical Grids, contributed paper presented at SIAM Fall meeting, Tempe, Arizona, 1985.

2 Archie G. Gibson

Professor Archie Gibson has installed one of the SUN workstations in his office. This Sun 2/160 workstation with a 71 megabyte hard disk was received in July, 1985. It was upgraded to a Sun 3/160 with an MC-68020 cpu in June, 1986. A Weitek floating point accelerator board was added in October, 1986.

This workstation has been used extensively by Professor Gibson and his collaborator Professor Colston Chandler of the UNM Physics Department. It is also being used by three of their Ph.D. students, Barbara Bertram, Bill Pletsch, and Henry Taijeron. This research has been supported by the National Science Foundation (NSF Grants PHY-8303738 and PHY-8603342). In addition, Dr. Gyula Bencze and Dr. Pal Doleschall of the Central Research Institute for Physics in Budapest, Hungary have used the workstation while visiting the University of New Mexico in September, 1985, and in April, 1986. They are also planning to visit again in April, 1987. These visits are exchange visits funded jointly by the National Science Foundation and the Hungarian Academy of Sciences (NSF Grant INT-8400053).

The work of Professors Gibson and Chandler and their associates involves their research in N-body quantum-mechanical scattering theory, and the development of an N-body computer code to make scattering calculations. The workstation has been used for the writing and running of symbolic manipulation codes using MACSYMA, and also for considerable number crunching of FORTRAN codes. They have ported almost all of their previous FORTRAN and MACSYMA software to the SUN workstation, and it all runs satisfactorily. This has almost completely eliminated their need to use the UNM mainframe computers and, consequently, has already saved thousands of dollars in computer expenses.

The four SUN workstations and the campus ethernet network purchased by the UNM Mathematics Department DoD/URIP grant has greatly facilitated the research of this group of investigators. The recent purchase of the DISSPLA graphics software package and an HP-7550 plotter will also facilitate the analysis and presentation of computed data. This group will continue to benefit from the availability of this "state of the art" computer equipment for many years.

The research of this group of researchers may be divided into three general areas, and the following three subsections describe their work in more detail.

2.1 Doleschall 3-Body Code

Dr. Pal Doleschall, of the Central Research Institute for Physics in Budapest, visited UNM in September, 1985, and in April, 1986. In September, he brought with him his complete 3-body Faddeev code and installed it on Professor Gibson's workstation. This code is probably the world's most sophisticated code based on Faddeev's equations. It was a laborious task getting this huge code to run on the SUN, but all of the necessary modifications were made, and several calculations have already been run. Some of these calculations initially took as many as 50 cpu hours, but these times were greatly reduced once the MC68020 upgrades were installed. Dr. Doleschall is planning to return to Albuquerque again in April, 1987, and continue his 3-body calculations.

2.2 Chandler-Gibson N-Body Code

The N-particle scattering code being developed by Professors Chandler and Gibson and their Ph.D. students is based on the Chandler-Gibson equations [1-6]. In this theory the N-particle scattering amplitude is determined from the on-shell limit of the solution of a system of coupled integral equations with a Cauchy singularity. The general approach to numerically solving this system of integral equations is the following.

The nonhomogeneous and kernel terms in this system of equations are large dimensional integrals. If the wave functions and potentials are Gaussians, then these integrals can be evaluated analytically with the aid of the symbol manipulation code MACSYMA. Since the actual wave functions and potentials are not Gaussians, they are being approximate by sums of Gaussians using a nonlinear least squares fitting routine. The output of the MACSYMA program are complicated functions [7] which are discretized and fit with bicubic splines. The resulting spline functions serve as the input to the system of Cauchy singular integral equations which is being solved numerically.

When some or all of the particles are identical, as is the case in nuclear reactions, the kernels of the approximate equations must be properly symmetrized. Physical channels are represented by equivalence classes of distinguishable particle states. The work of Bill Pletsch has been centered on studying how the effects of permutation symmetry, a nondynamical symmetry, can be taken into account in a way that is independent of the particular dynamical scheme. It therefore provides a starting point for the introduction of approximations that automatically satisfy the Pauli principle. Bill's work has been both theoretical and numerical. The numerical work has been greatly facilitated by having MACSYMA running on our Sun workstation.

Together with Barbara Bertram, we have essentially completed our investigation and comparison of methods for solving our singular integral equation [8,9]. In this investigation, we tried numerical quadrature, product integration, and moment methods. We have found that two of our methods work particularly well. One is a product quadrature method using piecewise linear interpolating polynomials, Chebyshev nodes, and a mapping of $[0, \infty]$ to $[-1, 1]$. The second method is an adaptation of the bicubic spline function moment method. Our solution procedure has now been implemented for an alpha-deuteron six-body model problem. In this model problem we are initially assuming that the particles are spinless and that no Coulomb potentials are present, but we are including the exchange effects arising from the Pauli principle. We have so far assumed that the elastic channel is the only open channel, but we have begun work on the inclusion of the breakup channel.

Because of the possibility of final state interactions, it is not clear that the usual partial-wave decomposition of the breakup amplitude is the best procedure. Indeed, at the recent Eleventh International Conference on Few Body Systems in Particle and Nuclear Physics in Tokyo, Japan, in August, 1986, it emerged that all partial waves through at least f-waves must be included in n-d three body calculations to obtain reliable results. Interest in alternatives to partial wave analysis was also expressed at the International Workshop on Few-Body Approaches to Nuclear Reactions in Tandem and Cyclotron Energy Regions, held in Tokyo just before the international few body conference.

Henry Taijeron has begun working with us on just this problem of how to incorporate the breakup channel in our computer code without the use of partial wave analysis. The approach is based on the use of spline functions on a sphere, an approach which has proved fruitful in the analysis of global geophysical data, as well as meteorological data. We are optimistic from work done so far that Henry will be able to generalize these splines to the five dimensional hypersphere appropriate to the breakup problem and produce a running computer code.

The main problem that we have at present with the breakup channels is the writing of MACSYMA codes to evaluate the input functions in our integral equations when the potentials and the wave functions of the bound clusters are sums of Gaussian functions. The expressions for these integrals turn out to be considerably more complicated than those for the elastic channel.

We have written a very stable and efficient nonlinear least squares fitting routine which will fit a sum of Gaussians to very general types of one-variable functions. We have used this routine to fit our wave functions and potentials with sums of Gaussians. Our particular method of approximating functions by sums of Gaussians is apparently new and has generated considerable interest. The exponents in our Gaussian approximations contain the tangents of Chebyshev points which arise in a rather natural way and are backed up by convergence theorems. One such theorem has been announced in [7], and we have now written a first draft of a paper containing the proof and some generalizations [10].

2.2.1 Low Energy Effects of Coulomb Plus Polarization Potentials

Proton-deuteron elastic scattering is a simple nonrelativistic problem where the potential of the interaction is the sum of a repulsive Coulomb potential and a polarization potential which does not decrease exponentially at infinity. It has recently been shown both numerically [11,12] and analytically [13] that the standard definition of a Coulomb-modified scattering length gives minus infinity! It was, in fact, argued twenty years ago by R. O. Berger and L. Spruch [14] that this scattering length was infinite. The numerical calculations in [12] took in excess of fifty cpu hours of time on our Sun workstation.

In recent joint work with Gy. Bencze, J. L. Friar, and G. L. Payne, we have shown how to define a long-range-modified scattering length which does exist [15] (an announcement of this work appears in [16]). This analysis has been confirmed by extensive numerical calculations for a two-body model problem. Our numerical investigations also indicate that there is no discernible effect of the long-range tail of the polarization potential at energies currently accessible by experiment. Most of these calculations were performed at Los Alamos National Laboratory, but a significant portion of the computations were checked using somewhat different codes on our Sun workstation.

References

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5. C. Chandler and A. G. Gibson, "N-Body Quantum Scattering Theory in Two Hilbert Spaces," preprint in preparation.

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8. A. G. Gibson, B. Bertram, and C. Chandler, in *Proceedings of the X. European Symposium on the Dynamics of Few-Body Systems*, edited by P. Doleschall (KFKI, Budapest, 1985), pp. 47-49.

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15. Gy. Bencze, C. Chandler, J. L. Friar, A. G. Gibson, and G. L. Payne, "Low Energy Scattering Theory for Coulomb plus Long-Range Potentials," submitted to Phys. Rev. C.

16. A. G. Gibson, "On Low Energy Scattering Theory with Coulomb Potentials," in Proceedings of the X. European Symposium on the Dynamics of Few-Body Systems, Vol. II (CRIP, Budapest, Hungary, 1986), pp. 355-365.

3 W. T. Kyner

Professor Kyner is using his work station to study autoradiographic methods and inverse problems in neurobiology. Autoradiographic methods are used to study the formation and movement of brain interstitial fluid. If a thin slice of brain tissue containing a radioactive tracer is left on a sheet of x-ray film, the gray levels of the developed film correspond to concentrations of the tracer. Image processing equipment can be used to quantify, display, and store the information contained in the x-ray picture of the brain tissue. With the aid of false color, patterns of transport of radioactive tracers can be investigated, and used in the construction of mathematical models.

W.T. Kyner of the Department of Mathematics and Statistics and G.A. Rosenberg of the Department of Neurology have been collaborating on a study of brain interstitial fluid and its regulating factors for several years. The equipment of the Image Processing Laboratory, UNM College of Engineering is being used for both the image processing and analysis aspects of the problem. The staff of the UNM Computing Center has helped set up a system for storing the images on tape and transferring them to a Sun Work station in Professor Kyner's office. Programs have been written that aid in the investigation of the transport of an extracellular tracer from the injection site in the brain of a laboratory animal. Agents that alter interstitial fluid transport can be injected along with the marker to determine their influence. The autoradiographs show that the transport in the immediate neighborhood of the injection site is radially symmetric. A crude model for the transport assumes that the injection process is a point source (the product of a time delta function and a space delta function) and that the transport is by diffusion in an infinite space. The concentration of the tracer is therefore modeled by $C(r) = A\exp(-B*r*r)$ where r is the distance from the injection site, A is a constant that depends on the amount of material injected, $B = 1/(4*D*t)$, t is the total elapsed time and D is the diffusion constant. Measured values of the concentration can be found from the autoradiograph and compared with the values predicted by the model so that the diffusion constant can be estimated. The values of D for control animals are close to those obtained in Rosenberg's laboratory by other methods. Animals treated with vasopression have diffusion constants that are different from the control animals. Further experiments are being done to establish the statistically significance of this difference. Other mathematical models that do not employ the point source injection are being studied and computer programs based on them are now being written. This description of the injection research program is rather simplified, for example, the transport in planes parallel to the one through the injection site, the effect of different volumes of injected fluid and different concentration of radioactive tracer are also being investigated.

Ferenc Varadi, who was visiting Professor Kyner from Eotvos University in Hungary, works on perturbation problems in applied mathematics. He used MACSYMA to investigate a perturbation problem connected to a nuclear spin-resonance method in oil-field research. The mathematical problem is to solve a non-autonomous linear system of differential equations with an exponentially decreasing non-autonomous part. This system can be solved using numerical methods or iterations, but these do not yield information on the solution for arbitrary values of the parameters. A special Lie series method can be used to find an approximate analytical solution. The method is a non-canonical version of the so-called Deprit method, modified to exploit some special properties of the problem. The MACSYMA program works for the first-order approximation, but the second-order calculation requires unreasonable computer resources. This is a typical phenomenon of algebraic manipulation on computers. Research on further optimization of this program is continuing. The final result of this project would be a fast algorithm for determining the ratio of the solid and liquid part of the soil. As a generalization of the method, it may be possible to find algorithms to carry out the so-called Lyapunov transformation using Lie series methods. Mr. Varadi is now at UCLA and is continuing this research.

Publications

1. Rosenberg, G. A., Kyner, W. T., Patlak, C. S., Effect of Vasopressin on ependynmal and capillary permeability to tritiated water in cat., J. Physiology (in press).

2. Tzamaloukas, A. H., Kyner, W. T., Galey, W. R., Determinants of osmotic phenomena created by an isolated change in extracellular solute in anuria, Min. Electr. Metab. (in press).

BUDGET OVERVIEW
January 12, 1987

GRANTS

DoD-AFOSR	166,468
UNM - Matching Funds	55,000
UNM - Additional Matching Funds	13,360
TOTAL	234,828

EXPENDITURES

SUN Computer Equipment	156,959.28
CDCN Network	58,216.03
Software	8,785.65
Miscellaneous	10,236.51
	234,419.47

BALANCE	630.53

SUN COMPUTER EQUIPMENT

DATE	DESCRIPTION	AMOUNT	SUBTOTAL	TOTAL
7/24/85	GIBSON COMPUTER			
	Color Sunstation 4MB Memory	23,862.50		
	Floating Point Processor	1,500.00		
	71 MB Disk & 1/4" Tape	5,925.00	31,287.50	
8/2/85	STEINBERG COMPUTER			
	Color Sunstation 4MB Memory	27,044.17		
	1/4" Cartridge Tape Subsystem	3400.00		
	Software/Doc 1/4" Cartridge; US	382.50		
	Software Documentation Only	637.50		
	380 MB Disk Subsystem	16,915.00	48,379.17	
6/27/85	KYNER COMPUTER			
	Color Sunstation 2MB Memory	21,612.50		
	71 MB Disk & 1/4" Tape	5,925.00	27,537.50	
6/27/85	BUYS COMPUTER			
	Color Sunstation 2MB Memory	21,612.50		
	71 MB Disk & 1/4" Tape	5,925.00	27,537.50	134,741.67
6/86	UPGRADES			
6/2/86	2 Upgrades 4MB	7,013.00		
	2 Upgrade 4MB	6,400.00		
	Freight Charges	47.81		
	4 mg expansion	4,800.00		
	Freight Charges	36.80		
	Floating Point Accelerator	3,920.00	22,133.00	
				156,959.28

CDCN EQUIPMENT

DATE	QTY	DESCRIPTION	AMOUNT	SUBTOTAL	TOTAL
12/30/85		Scientific Atlanta Cableflex (2250 ft.)	738.50		
	1	Scientific Atlanta Bridging Module	204.50		
	1	Scientific Atlanta Midsplit Station w/Trunk, (Auto Forward), Reverse, Power Supply, Bridge Module	1,426.38		
		Miscellaneous Broadband Supplies	92.40		
	2	Test Equipment Rental (month)	2,520.00		
		Shipping Charges	182.00		
		SUBTOTAL BROADBAND EQUIP/SUPPLIES		5,163.78	
	1	U.B. RF Moden (4a/r)	779.00		
	10	U.B. NIU 180 Baseband (2281a)	24,190.00		
	1	U.B. Broadband-Baseband Local Bridge (2731a)	8,077.00		
	12	U.B. Transceiver Cable ($100/ea.)	1,200.00		
	15	U.B. Transceivers (5201c) ($323.90/ea.)	4,858.50		
	1	Ethernet Cable (500 meters)	2,600.00		
	2	N-Plugs + 50 ohm Terminators ($25/ea.)	50.00		
		Repair of Local Bridge	550.00		
		RS-232 Cable (3000 ft)	2,190.00		
	160	RS-232 Connectors ($3.33/ea.)	532.80		
		Shipping Charges	144.00		
		SUBTOTAL ETHERNET EQUIP/SUPPLIES		45,171.30	
	144	Computing Center Labor ($23.00/hr.)	3,312.00		
	209	Physical Plant labor ($10.50/hr.)	2,194.50		
		SUBTOTAL LABOR		5,506.50	
					55,841.58
6/2/86		CCI Bridge	2,374.45		58,216.03

SOFTWARE

DATE	DESCRIPTION	AMOUNT	SUBTOTAL	TOTAL
11/26/86	TEX82 – University of Washington	75.00		
6/20/86	DISSPLA – ISSCO Graphics	3,120.00		
6/20/86	DISSPLA Manuals	600.00		
6/27/86	MACSYMA – Computer-Aided Math	6.00		
3/27/86	TEX82 – University of Washington	75.00		
3/27/86	Symbolics	16.65		
1/9/86	MAPLE – University of Waterloo	358.00		
10/16/85	TEX82 – University of Washington	75.00		
10/11/85	MACSYMA Manuals – Symbolic Corp.	360.00		
9/4/85	SUN Users Group	100.00		
5/22/85	MACSYMA – Symbolics Corp.	2,000.00		
5/25/85	SMP – Inference Corp.	2,000.00		
				8,785.65

MISCELLANEOUS

DATE	DESCRIPTION	AMOUNT	SUBTOTAL	TOTAL
4/4/85	Vampire Connectors	1,400.00		
7/1/85	Physical Plant (Shelves for NIUs)	527.00		
7/22/85	Electronic Parts - SL Datagard	159.80		
8/13/85	Data Documents - Tapes	275.20		
8/14/85	Integrated Management - Hayes Modem	405.00		
8/15/85	Systems Furniture - Electronic Bay	237.50		
8/30/85	Stanly Steinberg - Reimbursement (Tools)	40.65		
9/12/85	Computing Center - Pull RS-232	63.00		
9/26/85	UNM Post Office	18.17		
10/11/85	Data Documents - Tapes	294.70		
10/16/85	Fabric Works - Acoustic Panel	312.00		
10/23/85	Computing Center - RS-232 Cable	75.00		
10/25/85	Airborne Freight - Return to SUN	181.34		
11/22/85	Integrated Management - Hayes Modem	410.00		
12/20/85	UNM Post Office	19.80		
1/3/86	Systems Furniture	11.66		
1/13/86	Dept. of Mathematics - Reimbursement	34.13		
1/31/86	Telecommunications - Moving of phone line	78.92		
2/21/86	Computing Center - Moving of NIU	200.00		
3/3/86	Data Documents - Tapes	294.70		
3/24/86	Computing Center - RS-232 Cable	50.00		
5/22/86	Federal Express	23.20		
7/1/86	Federal Express	29.00		
7/7/86	TAB - Printer Stand	236.75		
7/7/86	NMT - HP 7750A Plotter	2,762.00		
9/5/86	Integrated Mgmt. - Modem	405.00		
9/5/86	Devoke - Footrest	31.00		
9/5/86	NMT - Plotter Supplies	108.00		
9/30/86	Federal Express	126.99		
1/7/87	CompuSave - TVI 905 (4)	1,140.00		
1/7/87	Rocky Mtn. Computers - Printer	286.00		
				10,236.51

END

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